# Benchmark *DAC2 HGC*
# Instruction Manual

## Reference Stereo Preamplifier
### PCM and DSD D/A Converter
### Headphone Amp • Asynchronous USB

...the measure of excellence!™

# Safety Information

## Fuses

**CAUTION: FOR CONTINUED FIRE HAZARD PROTECTION ALWAYS REPLACE THE FUSES WITH THE CORRECT SIZE AND TYPE (0.5A 250 V SLO-BLO® 5 X 20 MM – LITTELFUSE® HXP218.500 OR EQUIVALENT). THE FUSE DRAWER INCLUDES TWO FUSES. ALWAYS REPLACE BOTH FUSES AT THE SAME TIME.**

## Voltage Selection

**THE DAC2 HGC IS EQUIPPED WITH A UNIVERSAL POWER SUPPLY. THERE IS NO VOLTAGE SELECTION SWITCH. AC VOLTAGE RANGE IS 88-264 VAC, 50-60 HZ. THE PRODUCT MAY ALSO BE OPERATED FROM DC POWER OVER A VOLTAGE RANGE OF 125-373 VDC.**

## Power Cord

**CAUTION: ALWAYS USE A GROUNDED POWER CORD. THE PRODUCT IS EQUIPPED WITH A STANDARD IEC POWER ENTRY MODULE. USE AN IEC POWER CORD THAT IS EQUIPPED WITH THE APPROPRIATE CONNECTOR FOR YOUR LOCATION. CORDS ARE AVAILABLE FROM YOUR DEALER.**

## Modifications

**CAUTION: DO NOT SUBSTITUTE PARTS OR MAKE ANY MODIFICATIONS WITHOUT THE WRITTEN APPROVAL OF BENCHMARK MEDIA SYSTEMS, INC. MODIFICATION MAY CREATE SAFETY HAZARDS AND VOID THE WARRANTY.**

**NOTICE: CHANGES OR MODIFICATIONS NOT EXPRESSLY APPROVED BY BENCHMARK MEDIA SYSTEMS COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT UNDER FCC REGULATIONS.**

## Repairs

**CAUTION: DO NOT SERVICE OR REPAIR THIS PRODUCT UNLESS PROPERLY QUALIFIED. ONLY A QUALIFIED TECHNICIAN SHOULD PERFORM REPAIRS.**

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# Features

The ***DAC2 HGC*** is a reference-grade digital to analog converter, stereo system pre-amplifier, and headphone amplifier with infrared remote control. It supports D/A conversion of PCM sample rates up to 192 kHz, as well as direct DSD conversion.

- ***HGC™*** (Hybrid Gain Control) – combines motor-driven active analog pot, 32-bit digital attenuation, and passive analog attenuators, to achieve state-of-the-art performance
- ***Sabre*** - 32-bit PCM D/A conversion system, four 32-bit D/A converters per channel
- ***Sabre*** – Native DSD D/A conversion system, four 1-bit DSD D/A converters per channel
- ***HPA2™*** reference-grade ***headphone amplifier*** with dual outputs - "0-Ohm", high-current
- ***Multi-Mode Asynchronous USB Audio 2.0*** – 24 bit/192 kHz, DSD (DoP 1.1)
- Driverless ***Asynchronous USB Audio 1.1*** – 24-bit/96 kHz
- ***Benchmark UltraLock2™ Jitter Attenuation System*** – eliminates jitter-induced distortion
- ***Sample Rate Display*** – 44.1, 48, 88.2, 96, 176.4, 192 kHz and DSD
- ***Word Length Display*** – 16-bit, 24-bit
- ***2 Coaxial Digital Inputs*** – 24-bit/192 kHz PCM, DSD (DoP 1.1)
- ***2 Optical Digital Inputs*** – 24-bit/96 kHz PCM
- ***1 Coaxial Digital Output*** – digital pass through from USB, Coax, and optical inputs
- Metal ***IR Remote*** provides control of all functions
- ***2 Stereo Analog Inputs*** – 2 pairs, unbalanced (RCA)
- ***3 Stereo Analog Outputs*** – 1 pair, balanced (XLR), plus 2 pairs unbalanced (RCA)
- ***Low-Impedance Passive Output Pads*** – 0, 10, and 20 dB – optimize output level to power amplifiers to maximize SNR
- ***2 HPA2™ Headphone Outputs*** – one output has option to automatically mute main outputs
- ***HPA2™*** gain jumpers for customizing headphone output gain for headphone sensitivities
- ***12V Trigger I/O*** – bi-directional 12V trigger can act as input, output, or both
- ***Home Theatre Bypass*** – places selected input(s) in a fixed-gain pass-through mode
- ***Polarity Switch*** – inverts the polarity of selected digital inputs
- ***Mute and Dim Functions*** – accessible from remote or front panel
- **Automatic De-Emphasis** - in response to consumer pre-emphasis bit (44.1, 48 kHz)
- ***Power Switch*** - very low standby power - <0.5 W at 120 VAC
- ***High-Efficiency Low-Noise Power Supplies*** – only 12-15 W, 88-264 VAC, 50-60 Hz
- Meets FCC Class B and CE emissions requirements
- Tested for immunity to radiated and conducted RF interference

# Overview

The ***DAC2 HGC*** builds upon Benchmark's highly successful ***DAC1*** product family. Every ***DAC1*** subsystem has been redesigned and upgraded to achieve higher performance. The ***DAC2 HGC*** includes an updated version of Benchmark's highly-effective UltraLock™ jitter-attenuation system.

New features have been added to extend the versatility of the product, and improve the listening experience. These features include: native DSD conversion, asynchronous USB 2.0, asynchronous USB 1.1, home theater bypass, digital pass-through, polarity control, word-length display, sample-rate display, a bi-directional 12V trigger, and additional I/O.

The ***DAC2 HGC*** includes Benchmark's high-performance ***HPA2™***headphone amplifier, and Benchmark's metal remote control.

# Performance Improvements

## Lower Noise than the DAC1

Four balanced 32-bit digital-to-analog audio converters are summed together to form each balanced output channel. The 4:1 summing reduces noise by about 6 dB. Overall, the ***DAC2 HGC*** is about 10 dB quieter than the ***DAC1***. Low-level musical details are faithfully reproduced over a breathtakingly quiet noise floor.

## Lower Distortion than the DAC1

Benchmark's ***DAC1*** converters are known for their very low distortion (THD and IMD). The ***DAC2 HGC*** sets new benchmarks for clean and transparent musical reproduction.

## Low Power Consumption

The ***DAC2 HGC*** uses high-efficiency low-noise power supplies. Each critical subsystem has at least one dedicated low-noise regulator. The unit runs cool while providing substantial power to the headphone and output drivers. A power switch is included.

## *UltraLock2*™ Clock System

***UltraLock2™*** provides the outstanding jitter attenuation of the older ***UltraLock™*** system while providing a higher SNR.

## High-Headroom Digital Processing

All digital processing includes at least 3.5 dB headroom above an input level of 0 dBFS. This prevents all clipping in the digital processing, and provides clean and transparent audio reproduction.

# New Features

## Native DSD Conversion

The ***DAC2 HGC*** supports native DSD conversion. DSD signals can be delivered to the USB or Coaxial inputs in DoP 1.1 format. The DSD signal is then routed directly to a bank of 1-bit DSD D/A converters. Four balanced 1-bit converters are summed together for each balanced output.

## Asynchronous USB 2.0

The USB interface supports DSD and 192 kHz, 24-bit PCM. The ***DAC2 HGC*** generates the conversion clocks and totally eliminates the USB interface as a source of jitter. No drivers are required for Apple operating systems. Drivers are provided for Windows operating systems.

## Native Asynchronous USB 1.1

The ***DAC2 HGC*** has a driverless USB 1.1 mode that supports 96 kHz, 24-bit PCM with all operating systems. This mode provides quick and easy connection to a wide variety of computers and tablets.

## New Hybrid Gain Control

***HGC™*** is Benchmark's unique Hybrid Gain Control that combines active analog, 32-bit digital, and passive analog attenuation systems. ***HGC™*** puts an end to the debate about analog versus digital gain controls, and passive versus active analog attenuation. The dual-domain ***HGC™*** system combines the high dynamic range of Benchmark's **HDR™** analog control with the low distortion, and accuracy of digital control. ***HGC™*** outperforms traditional analog or digital volume controls, including the two-stage ***DAC1 HDR™*** system. Musical details are preserved over a very wide range of output levels. Analog inputs are controlled in the analog domain. Digital inputs are controlled in both domains.

The volume control is a servo-driven analog pot. This control rotates in response to commands from the remote control while providing the convenience of manual adjustments.

Low-impedance passive output attenuators optimize the gain range of the active analog and digital gain sections.

## Home Theater Bypass

Any input can be placed in a fixed-gain home theater bypass mode. The ***DAC2 HGC*** can drive the left and right power amplifiers, while the home theater system drives all other power amplifiers. When the home theater mode is in use, left and right audio passes through the ***DAC2 HGC*** at unity gain, and the home theatre system controls the audio level.

## Digital Pass-Through

The second coaxial input (**D4**) can be reconfigured as a digital output. When operating as an output, any selected digital input is passed through to (**D4**) without any processing. Optical, coaxial, and USB inputs can be passed through to the (**D4**) connector. This even includes special signals such as DoP, DTS, Dolby Digital, etc.

## Polarity Control

Each digital input can be inverted to correct polarity problems. Some listeners report that polarity is incorrect on some recordings, and that they enjoy an improved listening experience when this is corrected.

## Bi-directional 12V Trigger

The 12V trigger can be connected to other audio components so that an entire audio system can turn on an off in a sequenced fashion. The ***DAC2 HGC*** trigger I/O could be connected to a preamplifier, power amplifier, or both. The ***DAC2 HGC*** will pull the trigger I/O to 12 volts DC when the ***DAC2 HGC*** turns on. If an external device pulls the trigger I/O to 12 volts, the ***DAC2 HGC*** will turn on.

## Expanded I/O

The ***DAC2 HGC*** has:

- 2 stereo unbalanced analog inputs
- 2 optical inputs
- 2 coaxial inputs
- 1 USB input
- 2 stereo unbalanced outputs
- 1 balanced stereo output
- 1 bi-directional 12 volt trigger

## Applications

The ***DAC2 HGC*** is designed for maximum transparency and purity. The sonic integrity of the ***DAC2 HGC*** makes it well suited for critical playback in recording studio control rooms and mastering rooms. The versatility of the ***DAC2 HGC*** makes it an asset to any high-end audiophile application, including: HDTV, DVD, digital cable, music server, digital radio, analog radio, phono playback, portable music player, etc.

Benchmark's **Multi-Mode Asynchronous *USB*™** interface makes the ***DAC2 HGC*** an ideal output device for computer-based media playback, including: home media servers, digital audio workstations, desktop audio editing application, and computer-based radio broadcast systems.

## *DAC1* Heritage

The pristine audio performance of the award-winning ***DAC1*** made it the 'Benchmark' of stand-alone D/A converters. The ***DAC1 USB*** and ***DAC1 PRE*** , and ***DAC1 HDR*** added features but only achieved minor performance improvements. Performance of the DAC1 family was limited by the analog audio circuitry with state of the art opamps, as well as adding some of the most frequently requested features. The ***DAC2 HGC*** continues this tradition of perfectionism by adding many new features.

With the introduction of the ***DAC1 USB*** we added an advanced USB input with native 96-kHz / 24-kHz capability, an auto-mute function for headphone use, customizable headphone gain range, an auto-standby feature, and a high-current LM4562/LME49860 output stage designed to drive difficult loads.

The ***DAC1 PRE*** added the versatility of a stereo analog input and three S/PDIF digital inputs. The LM4562/LME49860 opamps were used throughout the analog section, and all RCA connectors were upgraded to premium bulkhead mounted RCA connectors for maximum durability and superior grounding.

The ***DAC1 HDR*** added a remote-control and the ***HDR-VC™*** volume control. The ***HDR-VC™*** volume control is built with a custom-made, motor-driven Alps potentiometer. The intelligent volume control allows the user to easily control the 'Normal' and 'Dim' / 'Soft-Mute' settings independently for ultimate flexibility.

The ***DAC2 HGC*** adds 32-bit D/A conversion, native 24-bit/192kHz PCM, native DSD conversion, multi-mode Asynchronous USB, sample rate and word length displays, ***UltraLock2™*** jitter attenuation, polarity switch, home theater bypass, bi-directional 12V trigger. It also adds 1 additional stereo analog input, 1 additional optical input, a digital pass-through, and high-efficiency low-noise power supplies.

## *HPA2™* Headphone Amplifier

The ***HPA2™***is one of the most transparent headphone amplifiers available. It also is able to deliver high current and/or high signal levels, and is well suited for a wide variety of headphones. The near 0-Ohm output impedance provides outstanding damping of headphone drivers. This damping reduces distortion, and maintains control of the frequency response.

# Quick Start Guide

## Audio Inputs

The ***DAC2 HGC*** features two stereo analog inputs (RCA) and five stereo digital inputs (2 coaxial, 2 optical, and 1 USB). The coaxial and optical inputs accept professional (AES) and consumer (S/PDIF) data formats at word lengths up to 24-bits. The optical inputs are limited to 96 kHz sample rates. Use the coaxial inputs and the USB input for 192 kHz applications.

## Remote Control

The remote-control has the following functions (and their respective icons):

- 'ON' / 'OFF'
- 'Input Up' / 'Input Down'
- 'Volume Up' / 'Volume Down'
- 'Mute'
- 'Dim'

The 'Mute' and 'Dim' functions are used to gracefully silence the ***DAC2 HGC***. The 'Mute' function will fade the volume down before completely muting, and will ramp the volume up after un-muting. The 'Dim' function will also fade the volume down, but will not completely mute the audio. Dim is convenient for reducing volume to low levels during television or radio commercials or while conducting a conversation.

The level of the 'Dim' volume setting can easily be set by the user with the remote control. The ***DAC2 HGC*** will remember the user's preferred 'Dim' setting upon returning to 'Normal' mode, and will recall it when 'Dim' mode is engaged again.

To engage 'Dim' mode, press the 'Dim' button (). To set the level of the 'Dim' mode, simply press 'Volume up' or 'Volume down' button on the remote control until you achieve the desired 'Dim' level. To exit 'Dim' mode and return to 'Normal' mode, simply press the 'Dim' button again.

The 'Dim' level cannot be set higher than the 'Normal' level. A minimum offset will be reached when adjusting the 'Dim' level upward. This minimum offset occurs just below the 'Normal' level setting. If the user continues to raise the volume above the minimum offset, the ***DAC2 HGC*** will enter 'Normal' volume mode.

The 'Mute' button quickly fades the volume to a full mute, while moving the rotary volume control to the 'Dim' setting. When exiting 'Mute' mode, the volume will ramp up to the 'Normal' volume setting.

While in ‘Normal’ or ‘Dim’ mode, pressing the ‘OFF’ button will immediately mute the ***DAC2 HGC*** and place the system in standby. After 5 minutes of inactivity, the displays will shut down, but all circuits will remain active. Press the power button twice to shut the system down and save power.

## Direct Interfacing to Power Amplifiers

The ***DAC2 HGC*** is designed to be able to interface directly to power amps and powered studio monitors. This configuration provides the cleanest and shortest path from the digital source to the monitor output and often results in a substantial improvement in sound quality.

The ***DAC2 HGC*** is equipped with 10 and 20 dB output attenuators for optimal interfacing. The pads optimize the output signal level of the ***DAC2 HGC*** to the input sensitivity of virtually any load (amplifier, preamp, etc). Most power amplifiers and powered monitors require the 10 dB or 20 pad setting. The ***DAC2 HGC*** is factory-set with the 10 dB pad enabled.

## Mute on Headphone Insertion

The left-hand headphone jack includes a switch that mutes the main analog outputs (XLR and RCA) when a headphone plug is inserted. This feature allows the listener to switch from loudspeaker to headphone playback seamlessly. This mute feature can be disabled with internal jumpers.

# Front Panel

## Input Status Display

The ***DAC2 HGC*** has eight LED status indicators on the front panel.

### Status Codes:

- **Single LED lit** – 'Normal' operating condition with selected input
- **Single flashing LED** – error condition on selected input
- **All LED's lit** – 'Mute' mode
- **All LED's lit except selected input** – 'Dim' mode
- **No LED's lit** – 'OFF' mode or no power

The LEDs labeled "A1" and "A2" correspond to analog input 1 and analog input 2. The LED labeled "U" corresponds to the USB input. The numbered labels match the numbers adjacent to the digital connectors on the rear panel. "D1" and "D2" are TOSLINK Optical digital inputs. Inputs "D3" and "D4" are RCA Coaxial digital inputs.

## Error Indication

The **Input Status Display** will flash when an error occurs on the selected digital input. The type of error is indicated by the frequency of the flashes.

### Error Codes:

- **Very slow flashes –** No signal – audio muted
- **Slow flashes –** Data transmission errors or Non-PCM –audio muted
- **Rapid flashes** – Non-audio – audio muted
- **Very rapid flashes** – Invalid sample (v-bit) – no mute

Common causes of errors are:

- Disconnected cable
- Data drop-outs due to a bad cable
- Incompatible data type (AC3, ADAT, etc.)
- Non-Audio data

There is no error indication on the analog inputs.

## Buttons

**Power** – Turns the unit on and off. Press once to turn on. Press once to enter standby mode, press twice to turn off.

**Dim/Mute –** Engages and disengages the dim and mute function. If the button is held down for more than 2 seconds, it will engage the ***Home Theater Bypass*** on the selected channel.

**Polarity** – Toggles the polarity of the selected input (digital inputs only). LED is on when polarity is inverted.

**Input** – Press the input select buttons to change the input.

### USB Mode Selection

To change the USB mode, select the USB input, and then press and hold both input select buttons (on the faceplate). After holding the buttons for 2 seconds, either the **4X** LED or the **2X** LED will flash once indicating the new USB mode. The **4X** LED flash indicates that the unit is engaged in USB 2.0. The **2X** LED flash indicates that the unit is in engaged in USB Audio 1.1. The **4X** or **2X** LED will flash once every time the USB input is selected. This flash provides an indication of the USB mode. We recommend stopping your computer playback before changing the USB mode. Pressing and holding the USB button on the remote for 2 seconds will also change the USB mode.

## Input Status Display

Under normal operation, the **Input Status Display** shows which of the 7 inputs is selected. A single steady light indicates that a proper signal is present and 'Normal' volume mode is selected. When all LED's are lit, the display indicates that the ***DAC2 HGC*** is muted. When all but one LED are lit, the display indicates that the ***DAC2 HGC*** is in 'dim'-mode. Flashing lights indicate error conditions.

## Word-Length Display

The word-length display is indicated by the two LEDs labeled **16** (16-bit) and **24** (24-bit). When a 16-bit track is played, the **16** LED will light up and vice versa when a 24-bit track is played. If a DSD track is played, both the **16** and **24** LEDs will turn off. Compressed MP3 files will display as 24-bits when originating from a player with a 24-bit MP3 decoder.

## Sample Rate Display

The sample rate display is indicated by the four LEDs labeled **44, 48, 2X, and 4X.**

**Sample Rate Reference**
44.1 kHz = **44** LED
48 kHz = **48** LED
88.2 kHz = **44** and **2X** LEDs
96 kHz = **48** and **2X** LEDs
176.4 kHz = **44** and **4X** LEDs
192 kHz = **48** and **4X** LEDs
DSD = **2X** and **4X** LEDs

## *HPA2*™ Headphone Jacks

The ***DAC2 HGC*** features two headphone jacks. The left-hand jack is equipped with a switch that automatically mutes the XLR and RCA analog outputs when a headphone plug is inserted. The right-hand jack has no switch. This feature enables seamless muting of the main outputs when headphones are being used. This auto-mute feature can be enabled or disabled via an internal jumper. Instructions for setting the auto-mute jumper are detailed in the '**Internal Settings**' section of this manual.

**TIP: Use the left-hand jack to mute your loudspeaker system. Use the right-hand jack to keep all outputs active**.

The dual jacks also allow two listeners to monitor and compare notes on what is heard. When comparing, we recommend using identical headphones because headphone sensitivities differ significantly. The **Volume Control** adjusts the level for both jacks.

The gain of the ***HPA2***™ is high enough for the most difficult headphones, but it may be too high for some other headphones. The ***HPA2***™ in the ***DAC2 HGC*** features three gain ranges to customize the output level for a particular set of headphones. These gain ranges are set using internal jumpers. The jumpers reduce the input to the ***HPA2***™ by 0, 10 or 20 dB. These jumpers are factory-installed at 10 dB below full gain. Instructions for setting the headphone gain range are detailed in the 'Internal Settings' section of this manual.

**TIP: For optimal performance, the headphone gain jumpers should be set so that comfortable listening levels occur when the 'Volume Control' is set above the '11 o'clock' position.**

## *HGC™* Volume Control

## Hybrid Gain Control™

"HGC" is Benchmark's unique **Hybrid Gain Control™** system. The **DAC2 HGC** combines active analog gain control, passive low-impedance attenuators, a 32-bit digital gain control, and a servo-driven volume control. All inputs are controlled by the rotary volume control. This volume control moves in response to commands from the remote control. Analog inputs are never converted to digital, and digital inputs never pass through an analog potentiometer. Digital inputs are precisely controlled in the 32-bit DSP system. The DSP system preserves precise L/R balance, and precise stereo imaging, while avoiding any source of noise and distortion. Benchmark's unique passive output attenuators provide distortion-free gain reduction without reducing the dynamic range of the converter. The attenuators optimize the gain staging between the **DAC2 HGC** and the power amplifier. This optimization is absolutely essential for maximizing the dynamic range of the entire playback system. Much of the success of the **DAC1** converters can be attributed to the passive output attenuators. Musical details can be obscured by system noise whenever a preamplifier and power amplifier are improperly matched. The **HGC** system will make full use of your power amplifier's dynamic range. Experience the new details in your favorite recordings.

The front-panel volume control is a servo-driven gain circuit control built around a custom-made Alps potentiometer. The custom Alps pot is equipped with remote-controllable motor drive.

This potentiometer is equipped with a clutch which prevents damage from overriding the motor drive. If the pot is driven beyond the end of its range, it will not damage the motor. Also, if the pot is manually overridden, it will not damage the motor.

The XLR outputs have jumper-enabled passive attenuators that can be used to optimize the gain structure of the playback system.

**TIP: For optimal performance and minimal noise, the XLR gain jumpers should be set so that comfortable listening levels occur when the 'Volume Control' is set above 11 o'clock.**

Instructions for setting the XLR pads are detailed in the 'Internal Settings' section of this manual. The ***DAC2 HGC*** is shipped with the XLR attenuation set to -10 dB.

# Rear Panel

## Inputs

There are seven stereo inputs on the ***DAC2 HGC***: 2 x Analog, 1 x USB, 2 x Optical, and 2 x Coaxial. These inputs are selected using the front-panel **Input** control, or the remote.

The optical and coaxial can decode AES/EBU and S/PDIF input signals in either professional or consumer formats.

**TIP: The *DAC2 HGC* will not decode AC3 or ADAT signals. The 'Status Display' will flash when AC3, ADAT, or other non-PCM input signals are connected to the selected digital input.**

The Benchmark ***UltraLock2***™ system removes interface jitter from all digital inputs (including the USB input). The result is that all digital inputs have identical jitter performance.

### Analog Inputs – RCA Unbalanced

The ***DAC2 HGC*** has 2 unbalanced stereo analog inputs via 2 pairs of RCA connectors.

The analog inputs can be used for devices such as:

- Phono preamplifiers
- FM Tuners
- Tape Transports
- Analog VCR outputs
- iPod and MP3 devices
- Outputs from analog mixing consoles

### Computer Input – USB

The USB input accepts a 'B-type' male USB 1.1 or USB 2.0 connector. An 'A-B type' USB cable is provided with the ***DAC2 HGC***. The USB cable connects the ***DAC2 HGC*** directly to a computer's USB output. The USB interface utilizes USB 1.1 and USB 2.0 protocol, and is compatible with both USB 1.1 and USB 2.0 ports.

The USB input supports 44.1, 48, 88.2, 96, 176.4, and 192 kHz sample rates at word

lengths up to 24-bits. The USB also accepts DSD. The USB interface acts as a 'native' USB audio device and does not require the installation of any custom drivers if listening to music up to 96 kHz on either Mac OS X or Windows. Drivers are required for listening to music up to 192 kHz and DSD only for Windows. Drivers are not required for Mac OS X for 192 kHz and DSD playback.

On USB 1.1, the Benchmark USB interface is truly a plug-and-play solution. The ***DAC2 HGC*** can begin streaming high resolution 24-bit/96 kHz audio bit-transparently within seconds after being plugged into a computer for the first time. No software or hardware configuration is required.

The ***DAC2 HGC's*** USB 1.1 is designed, tested and proven compatible with Windows XP/Vista/Windows 7 and Mac OS X with no driver installation or system configuration required.

The ***DAC2 HGC's*** USB 2.0 is designed, tested and proven compatible with Windows XP/Vista/Windows 7 with driver installation. It was also test on Mac OS X versions 10.6, 10.7, and 10.8 with no driver installation.

For the up-to-date information about more recent operating systems and suggestions for optimization, go to: www.benchmarkmedia.com/wiki.

## Optical Digital Inputs - D1 and D2

The optical input connector is commonly known as a TOSLINK connector. The TOSLINK optical connector used on the ***DAC2 HGC*** is designed to work well at sample rates up to 96 kHz. Maximum word length is 24-bits. All sample rates between 28 and 96 kHz are supported. The optical input will accept professional AES/EBU data formats or consumer S/PDIF data formats.

## Coaxial Digital - D3 and D4

The coaxial inputs use female RCA connectors that are securely mounted directly to the rear panel. The input impedance is 75 Ohms. Maximum word length is 24-bits. All sample rates between 28 and 195 kHz are supported.

The Coax inputs are DC isolated, transformer coupled, current limited, and diode protected. The RCA body is bonded directly to the chassis to prevent currents in the internal ground systems. This direct bonding also maximizes RF shielding.

**TIP: Shielded 75-Ohm coaxial cable is required for stable performance. Do not use 50-Ohm cables or twisted pair cables, or any non-coaxial cables.**

The Coaxial inputs accept AES/EBU or S/PDIF digital audio formats. AES3-id and SMPTE 276M standards specify 75-Ohm 1 Vpp professional format digital audio signals and these are commonly used in video production facilities. IEC 609588-3 specifies 75-Ohm 0.5 Vpp consumer-format digital audio signals (commonly known as S/PDIF). The coaxial inputs on the ***DAC2 HGC*** are designed to accept either type of signal.

# Outputs

## Analog Outputs

The ***DAC2 HGC*** has one unbalanced XLR and two balanced RCA outputs.

The ***DAC2 HGC*** features high-current output drivers that are capable of driving 300-Ohm loads without an increase in distortion. They are also well suited for driving long cables or high-capacitance loads.

## Balanced XLR Analog Line Outputs

The Left and Right balanced outputs use Neutrik™ gold-pin male XLR jacks. The XLR shell and pin 1 (ground) are both directly bonded to the chassis to prevent currents in the internal ground systems. This direct bonding also maximizes RF shielding.

The XLR outputs have passive attenuators that allow direct connections to a wide variety of audio devices without a loss of dynamic range. The 10 or 20 dB pads are usually required for direct interfacing to power amplifiers and powered speakers. The ***DAC2 HGC*** ships with the 10 dB pads enabled. A full description of the output attenuators and instructions for configuration is located in the **Internal Setting** section of this manual.

Industry-standard XLR wiring:

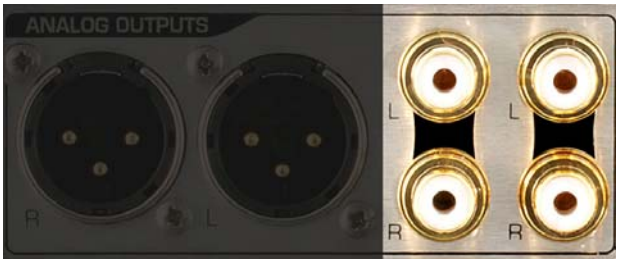
XLR pin 2 = + Audio Out

XLR pin 3 = - Audio Out

XLR pin 1 = Cable Shield

**CAUTION: If the balanced XLR outputs are wired to an unbalanced input (using a special adapter cable), pin 3 must be left floating. Shorting pin 3 to ground will increase the temperature of the output drivers, will increase power consumption, and may cause distortion.**

## Unbalanced RCA Analog Outputs




The Left and Right unbalanced outputs use standard RCA style jacks. The ground connections are bonded to chassis ground at the location where analog ground is bonded to the chassis. This minimizes the effects of ground loops caused by AC currents in the cable shield.

**TIP: Mono summing with an RCA 'Y' cable is not recommended as this will cause high amounts of distortion. Mono summing with a 'Y' cable can be accomplished with the use of a modified cable by implementing a 1k Ohm series resistor in each leg of the 'Y'.**

**Note:** The XLR pads do not have any effect on the level of the RCA outputs.

The RCA output impedance is very low (30 Ohms). This makes these outputs well suited for driving high-capacitance loads and/or high-capacitance cables.

**TIP: The RCA outputs are capable of driving cables as long as 1360 feet (see Table 1). But, long un-balanced cables will generally suffer from hum problems due to ground loops. We highly recommend using balanced interconnects for long runs.**

## AC Power-Entry and Fuse Module

## Power Cord

The AC power input uses a standard IEC type connector. One USA-compatible power cord is included with ***DAC2 HGC*** converters shipped to North America. IEC style power cords in country-specific configurations are available in your locality.

**CAUTION: ALWAYS USE A GROUNDED POWER CORD. THE PRODUCT IS EQUIPPED WITH A STANDARD IEC POWER ENTRY MODULE. USE AN IEC POWER CORD THAT IS EQUIPPED WITH THE APPROPRIATE CONNECTOR FOR YOUR LOCATION. CORDS ARE AVAILABLE FROM YOUR DEALER.**

## Fuses

**CAUTION: FOR CONTINUED FIRE HAZARD PROTECTION ALWAYS REPLACE THE FUSES WITH THE CORRECT SIZE AND TYPE (0.5A 250 V SLO-BLO® 5 X 20 MM – LITTELFUSE® HXP218.500 OR EQUIVALENT). THE FUSE DRAWER INCLUDES TWO FUSES. ALWAYS REPLACE BOTH FUSES AT THE SAME TIME.**

## Voltage Selection

**THE DAC2 HGC IS EQUIPPED WITH A UNIVERSAL POWER SUPPLY. THERE IS NO VOLTAGE SELECTION SWITCH. AC VOLTAGE RANGE IS 88-264 VAC, 50-60 HZ. THE PRODUCT MAY ALSO BE OPERATED FROM DC POWER OVER A VOLTAGE RANGE OF 125-373 VDC.**

# Internal Settings

## Removing Top Cover

The ***DAC2 HGC*** cover must be removed to gain access to the jumpers. Do not attempt to remove the faceplate or rear panel.

**CAUTION: The *DAC2 HGC* contains static sensitive components and should only be opened by qualified technicians. Static discharge may cause component failures, may affect the long-term reliability, or may degrade the audio performance. Use a static control wrist strap when changing jumper settings.**

**CAUTION:**

- **Disconnect AC power by unplugging the power cord at the back of the *DAC2 HGC*.**
- **Remove only the 8 screws holding the cover (4 on each side).**
- **Do not remove any screws on front or rear panels.**
- **Never remove the power entry safety cover in the rear corner of the *DAC2 HGC*.**
- **Always connect a static-control wrist strap to the chassis before touching any internal component.**

## Low-Impedance Passive Pads

The XLR outputs are equipped with low-impedance passive pads that may be used to reduce the output levels while preserving the full dynamic range of the ***DAC2 HGC***. The ***DAC2 HGC*** ships with the 10 dB pads enabled.

**TIP: When directly driving power amplifiers and powered speakers, use 'Variable' mode and start with the factory default 10 dB pad setting. If necessary, change the pads so that normal listening levels are achieved with the 'Volume Control' above the 11 o'clock position.**

When the output pads are enabled, the output impedance changes slightly, and the maximum allowable cable length should be reduced as shown in Table 1 (assuming 32 pF/foot and a maximum allowable loss of 0.1 dB at 20 kHz).

**Table 1 - Cable Drive Capability**

**Balanced Output Drive Capability:**

| Attenuator Setting (dB) | Output Impedance | Maximum Cable (ft) | Loss in dB at 20 kHz |
|---|---|---|---|
| 0 | 60 | 680 | 0.1 |
| 10 | 425 | 96 | 0.1 |
| 20 | 135 | 302 | 0.1 |

**Unbalanced Output Drive Capability:**

| Output Impedance | Maximum Cable (ft) | Loss in dB at 20 kHz |
|---|---|---|
| 30 | 1360 | 0.1 |

**TIP: To set the XLR outputs to typical professional studio levels, set the pads to 0 dB.**

## Jumpers

The following functions are jumper configured:

- Headphone Gain Range Adjustment
- Headphone Switch Disable
- XLR Output Pads
- Digital Pass Through Enable

### XLR Output Pad Selection (P8, P9, P10, and 11):

Four 8-pin headers (P8, P9, P10, and P11) allow selection of the output level at the XLR jacks.

One pair of 6-pin headers controls the output level at each XLR jack as follows:

- 0 dB - (Attenuator disabled) – (Jumper plug between pins 1 and 2 of each header)
- -10 dB – *** (Jumper plug between pins 3 and 4 of each header) – *Factory Default*
- -20 dB – (Jumper plug between pins 5 and 6 of each header)

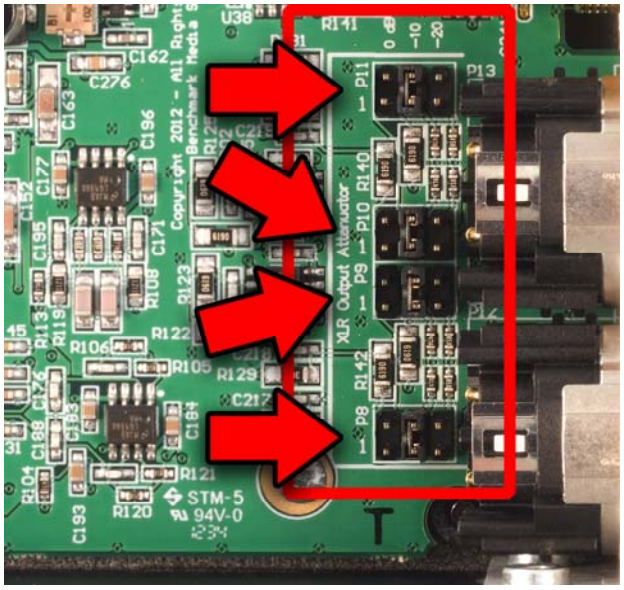



**Figure 1 - 10 dB (Factory Default)**

**Headphone Switch Disable (JP1 and JP2):**

The ***DAC2 HGC*** is configured so that the analog outputs will mute when a headphone plug is inserted into the left-hand jack. This is convenient when the user wishes to switch between headphones and speakers. This feature can be defeated by adding jumpers at JP1 and JP2.

JP1 and JP2 should be configured as follows:

- Headphone Switch enabled*** (Jumpers Removed)
- Headphone Switch disabled (Jumpers Inserted)

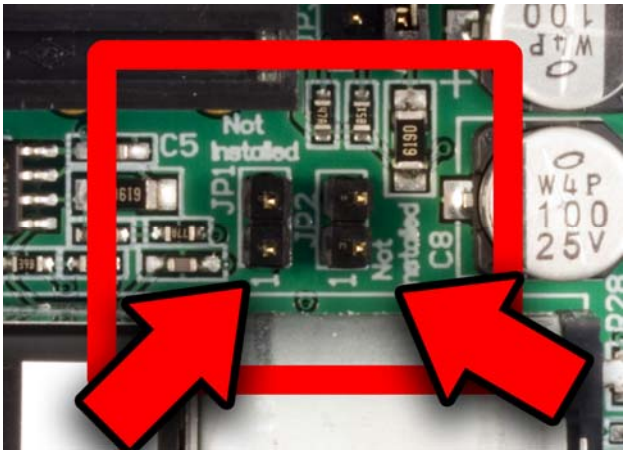



**Figure 2 *** - Factory Default**

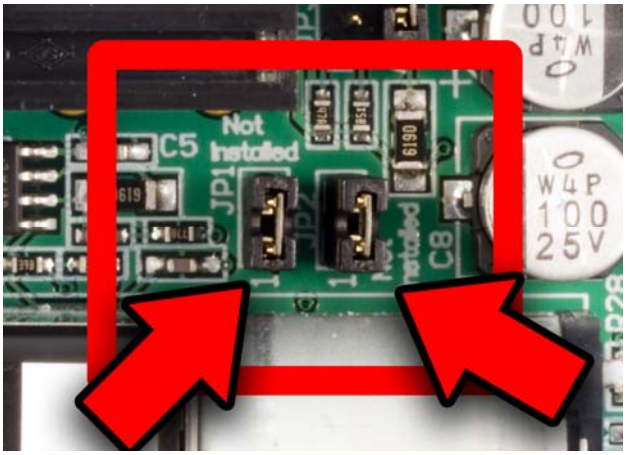



**Figure 3 - Disable Heaphone Switch**

## Headphone Gain Reduction (JP3 and JP4):

The gain range of the ***HPA2***™ can be set using jumpers JP3 and JP4. When jumpers are installed at position "A" the headphone amplifier gain is decreased by 20 dB. When jumpers are installed at position "B" the headphone amplifier gain is decreased by 10 dB.

The ideal gain setting permits the user to set the front-panel **Volume Control** above 40% (10 o'clock) without the headphone volume being too loud.

JP3 and JP4 are factory installed for a headphone attenuation of 10 dB. This setting is best for most applications. Move the jumpers according to example in Figure 4 for more gain or move the jumpers according to example in Figure 5 for less gain.

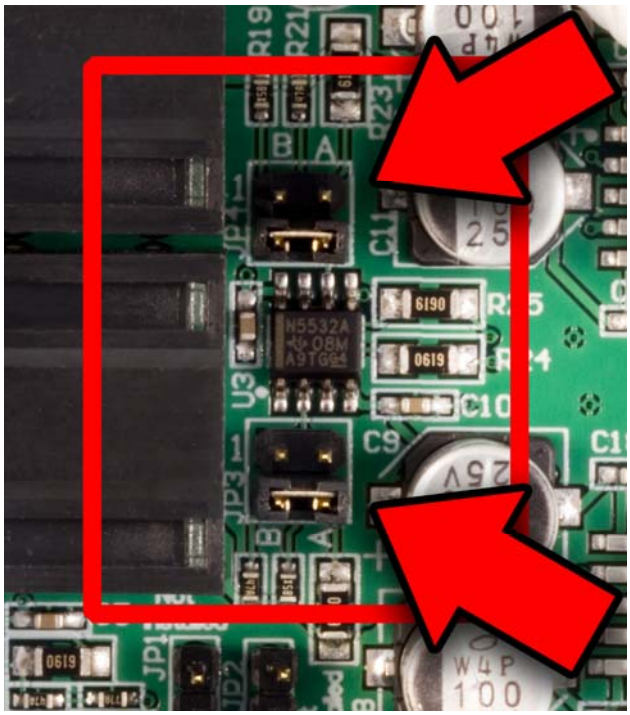


**Figure 4 - 10 dB (Factory default)**

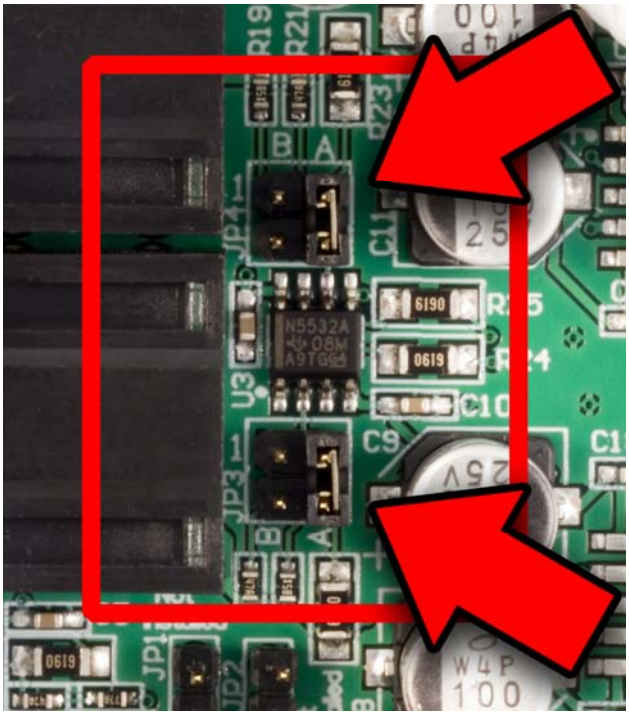


**Figure 5 - 0 dB**

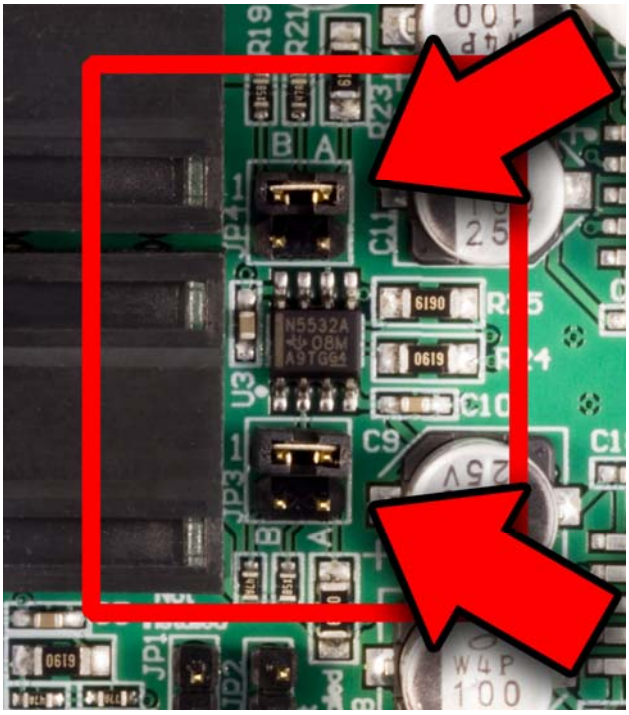


**Figure 6 - 20 dB**

# Rack Mounting

An optional rack mount adapter allows the mounting of any two Benchmark ***System1™*** products in a single rack space. A **Blank Rack Panel** can be added when only one unit is installed in the rack mount adapter.

The ***System1™ Universal Rack Adapter*** and ***Blank Rack Panel*** are available from Benchmark.

Call us, visit our website (http://www.BenchmarkMedia.com), or contact your dealer to purchase these accessories.

## *System1™* Universal Rack Adapter

The ***Universal Rack Mount Adapter*** is a tray that mounts up to two ½ RU Benchmark products in a single race space. The tray accepts any combination of ½ RU Benchmark products (with or without rack-mount type faceplates).

## Blank Rack Panel

The ***Blank Rack Panel*** is a ½-wide 1-RU black-anodized aluminum panel for covering an unused slot in a ***System1™ Universal Rack Adapter***.

# Benchmark Technologies

## Hybrid Gain Control™

"HGC" is Benchmark's unique **Hybrid Gain Control™** system. The **DAC2 HGC** combines active analog gain control, passive low-impedance attenuators, a 32-bit digital gain control, and a servo-driven volume control. All inputs are controlled by the rotary volume control. This volume control moves in response to commands from the remote control. Analog inputs are never converted to digital, and digital inputs never pass through an analog potentiometer. Digital inputs are precisely controlled in the 32-bit DSP system. The DSP system preserves precise L/R balance, and precise stereo imaging, while avoiding any source of noise and distortion. Benchmark's unique passive output attenuators provide distortion-free gain reduction without reducing the dynamic range of the converter. The attenuators optimize the gain staging between the **DAC2 HGC** and the power amplifier. This optimization is absolutely essential for maximizing the dynamic range of the entire playback system. Much of the success of the **DAC1** converters can be attributed to the passive output attenuators. Musical details can be obscured by system noise whenever a preamplifier and power amplifier are improperly matched. The "HGC" system will make full use of your power amplifier's dynamic range. Experience the new details in your favorite recordings.

## Native DSD Conversion

All digital inputs on the DAC2 HGC support native DSD conversion. DoP 1.1 is automatically detected on all digital inputs, and the system seamlessly switches to native DSD conversion. DoP 1.1 is supported by many media players, and DSD downloads are now available from several sources.

## Multi-Mode Asynchronous AdvancedUSB Audio™

Benchmark's USB system supports USB Audio 2.0, DSD, and USB Audio 1.1. It is frequency agile, and will follow sample rate changes initiated by the computer and/or the media playback software. In all modes the USB communications are asynchronous in order to eliminate unnecessary sources of jitter.

The **DAC2 HGC** has a low-jitter master clock which controls the transfer of audio data from the computer to the USB sub-system. The computer asynchronously transfers audio data to a buffer in the **DAC2 HGC**. The contents of the buffer are then asynchronously transferred to the D/A conversion sub-system. This second asynchronous transfer eliminates any traces of jitter that accumulate as the data is transferred between the USB and conversion subsystems. No traces of jitter-induced distortion are measurable to our measurement limits (better than -150 dBFS). This truly represents the state-of-the art. Enjoy the convenience of computer playback without compromise.

The Asynchronous USB system supports USB Audio 2.0 for high-resolution 192kHz, and DSD playback. No drivers are required for MAC operating systems. An easy-to-install driver adds 192 kHz and DSD capabilities to Windows operating systems.

An asynchronous driverless USB Audio 1.1 mode supports sample rates up to 96 kHz. This USB mode can be selected from the front panel or from the remote control. The driverless USB Audio 1.1 mode allows quick plug-and-play connections to Windows, MAC, iOS, and Linux operating systems without installing drivers. Just plug in the USB, and the **DAC2 HGC** becomes an available audio device.

The USB subsystem remains active when the **DAC2 HGC** is powered down. This prevents interruptions to the computer playback operations and eliminates the need to

reconfigure the computer every time the converter is turned on.

## Jitter-Immune *UltraLock2™*

***UltraLock2™*** is an improved version of the ***UltraLock™*** system used in the DAC1 and ADC1 product families. DSP processing is 32-bits, DSP headroom is 3.5 dB, sample rate is 211 kHz, and jitter-induced distortion and noise is at least 140 dB below the level of the music - well below the threshold of hearing. Benchmark's ***UltraLock2™*** system eliminates all audible jitter artifacts.

## High Head-Room DSP

All of the digital processing in the DAC2 HGC is designed to handle signals as high as +3.5 dBFS. Most digital systems clip signals that exceed 0 dBFS. The 0 dBFS limitation seems reasonable, as 0 dBFS is the highest sinusoidal signal level that can be represented in a digital system. However, a detailed investigation of the mathematics of PCM digital systems will reveal that inter-sample peaks may reach levels slightly higher than +3 dBFS while individual samples never exceed 0 dBFS. These inter-sample are common in commercial releases, and are of no consequence in a PCM system until they reach an interpolation process. But, for a variety of reasons, virtually all audio D/A converters use an interpolation process. The interpolation process is absolutely necessary to achieve 24-bit state-of-the art conversion performance. Unfortunately, inter-sample overs cause clipping in most interpolators. This clipping produces distortion products that are non-harmonic and non-musical. We believe these broadband distortion products often add a harshness or false high-frequency sparkle to digital reproduction. The DAC2 HGC avoids these problems by maintaining at least 3.5 dB of headroom in the entire conversion system. We believe this added headroom is a groundbreaking improvement.

## 32-bit SABRE Conversion System

Four balanced 32-bit D/A converters deliver audio to Benchmark's low-impedance current to voltage converters. The 4:1 redundancy reduces noise and distortion to levels that set new benchmarks. The conversion system at the core of the DAC2 HGC is as good as it gets. The analog circuits that follow the D/A converter are carefully designed. Benchmark has leveraged its long history of building high-end analog audio equipment, in order to create an outstanding output stage.

## Diagnostic Display

Ever wonder why that 192 kHz 24-bit download on your computer just doesn't sound right? Your media player may be down-sampling to 44.1 kHz and/or truncating to 16-bits. Many media players apply poor-quality sample rate conversion and truncation. Fortunately these problems can be eliminated with the selection a good frequency-agile media player. The sample-rate and word-length displays on the DAC2 HGC confirm the proper operation of your media player.

## Bi-Directional 12 Volt Trigger

Benchmark re-invents the 12 volt trigger. The trigger connection on the DAC2 HGC can be used as an input or output or both, and is compatible with any common 12 volt trigger input or output. The trigger can be used to turn a power amplifier on or off automatically. The DAC2 will also respond to a 12 volt trigger and follow the actions of another audio component.

## Distributed Power Regulation

To achieve the lowest possible noise, the DAC2 HGC uses distributed power supply regulation. Each critical subsystem has at least one dedicated low-noise voltage regulator.

## *HPA2*™ Headphone Amplifier

The ***DAC2 HGC*** headphone output is driven by Benchmark's signature ***HPA2***™ headphone amplifier. This high-current, high-output amplifier has an output impedance of near 0-Ohms. It is designed to drive loads as low as 30 Ohms without any increase in distortion. It also has sufficient amplitude to drive low-sensitivity 600-Ohm headphones.

The ***HPA2***™ includes current-limiting circuits that fully protect against damage from short circuits. This is important because the right channel of a headphone amplifier will experience a short whenever a mono phone plug is inserted into the stereo headphone jack. Shorts may also occur when a plug is partially inserted.

### 0-Ohm Output Impedance

Most headphone amplifiers use series resistors to maintain stability and protect against short-circuit conditions. These resistors are usually at least 30 Ohms, and have a negative impact on performance. A headphone amplifier with series resistors may measure very well when driving resistive loads. However, the same amplifier will measure very poorly when driving a headphone load. Unfortunately, most manufacturers do not specify headphone amplifier performance with anything other than ideal resistive loads. Our measurements show that headphones do not behave like resistive loads.

### Headphone Performance

In our tests we have measured substantial distortion across resistors that are wired in series with headphones. We conducted measurements with a variety of headphones. In general, distortion increases as headphone impedance decreases. This distortion can be eliminated with a properly designed 0-Ohm headphone amplifier.

The performance of the ***HPA2***™ does not change when headphones are driven. THD+N measurements for no-load, 30-Ohm resistive loads, 30-Ohm headphone loads, and 600-Ohm headphone loads are virtually identical. The ***HPA2***™ will substantially improve the sound of 30 and 60-Ohm headphones. It will make very noticeable improvements with 600-Ohm headphones.

## Differential Amplifiers

Differential amplifiers remove common-mode distortion components from the D/A converter outputs. This feature is critical for achieving low-distortion in down-stream devices. Benchmark addresses common-mode distortion so that it will not cause distortion in power amplifiers and other connected devices. Common-mode distortion can cause audible distortion while escaping the scrutiny of an audio analyzer. The balanced and unbalanced outputs on the DAC2 HGC deliver very similar performance.

Many D/A converters omit the differential amplifiers after the converters. Specifications usually ignore common-mode distortion, and. A balanced signal with high common-mode distortion can measure just fine when feeding a precisely balanced input on a high-quality audio analyzer. However, any imbalance in a downstream device will expose the common-mode distortion.

## *UltraLock2*™ Clock System

Accurate 24-bit audio conversion requires a very low-jitter conversion clock. Jitter can very easily turn a 24-bit converter into a 16-bit converter (or worse). There is no point in buying a 24-bit converter if clock jitter has not been adequately addressed.

Jitter is present on every digital audio interface. This type of jitter is known as '**interface jitter**' and it is present even in the most carefully designed audio systems. Interface jitter accumulates as digital signals travel down a cable and from one digital device to the next. If we measure interface jitter in a typical system we will find that it is 10 to 10,000 times higher than the maximum allowable level for accurate 24-bit conversion.

Fortunately, interface jitter has absolutely no effect on the audio unless it influences the conversion clock in an analog-to-digital converter (A/D) or in a digital-to-analog converter (D/A).

Many converters use a single-stage Phase Lock Loop (PLL) circuit to derive their conversion clocks from AES/EBU, Wordclock, or Superclock reference signals. Single-stage PLL circuits provide some jitter attenuation above 5 kHz but none below 5 kHz. Unfortunately, digital audio signals often have their strongest jitter components at 2 kHz. Consequently, these converters can achieve their rated performance only when driven from very low jitter sources and through very short cables. It is highly unlikely that any converter with a single-stage PLL can achieve better than 16 bits of performance in a typical installation. Specified performance may be severely degraded in most installations.

Better converters usually use a two-stage PLL circuit to filter out more of the interface jitter. In theory, a two-stage PLL can remove enough of the jitter to achieve accurate 24-bit conversion (and some do). However, not all two-stage PLL circuits are created equal. Many two-stage PLLs do not remove enough of the low-frequency jitter. In addition, two-stage PLL circuits often require several seconds to lock to an incoming signal. Finally, a two-stage PLL may fail to lock when jitter is too high, or when the reference sample frequency has drifted.

***UltraLock™*** converters exceed the jitter performance of two-stage PLL converters, and are free from the slow-lock and no-lock problems that can plague two-stage PLL designs. ***UltraLock™*** converters have extremely high immunity to interface jitter under all operating conditions. No jitter-induced artifacts can be detected using an Audio Precision System 2 Cascade test set. Measurement limits include detection of artifacts as low as –140 dBFS, application of jitter amplitudes as high as 12.75 UI, and application of jitter over a frequency range of 2 Hz to 200 kHz. Any AES/EBU signal that can be decoded by the AES/EBU receiver will be reproduced without the addition of any measurable jitter artifacts.

The ***DAC2 HGC*** employs Benchmark's ***UltraLock2™*** technology to eliminate jitter-induced performance problems. ***UltraLock2™*** technology isolates the conversion clock from the digital audio interface clock. Jitter on a D/A digital audio input, or an A/D reference input can never have any measurable effect on the conversion clock of an ***UltraLock2™*** converter. In an ***UltraLock2™*** converter, the conversion clock is never phase-locked to a reference clock. Instead the converter oversampling-ratio is varied with extremely high precision to achieve the proper phase relationship to the reference clock. The clock isolation of the ***UltraLock2™*** system insures that interface jitter can never degrade the quality of the audio conversion. Specified performance is consistent and repeatable in any installation with cables of any quality level!

## How does conversion clock jitter degrade converter performance?

**Problem #1:** Jitter phase modulates the audio signal. This modulation creates sidebands (unwanted tones) above and below every tone in the audio signal. Worse yet, these sidebands are often widely separated from the tones in the original signal.

Jitter-induced sidebands are not musical in nature because they are not harmonically related to the original audio. Furthermore, these sidebands are poorly masked (easy to hear) because they can be widely separated above and below the frequencies of the original audio tones. In many ways, jitter induced distortion resembles intermodulation distortion (IMD). Like IMD, jitter induced distortion is much more audible than harmonic distortion, and more audible than THD measurements would suggest.

Jitter creates 'new audio' that is not harmonically related to the original audio signal. This 'new audio' is unexpected and unwanted. It can cause a loss of imaging, and

can add a low and mid frequency 'muddiness' that was not in the original audio.

Jitter induced sidebands can be measured using an FFT analyzer.

**Problem #2:** Jitter can severely degrade the anti-alias filters in an oversampling converter. This is a little known but easily measurable effect. Most audio converters operate at high oversampling ratios. This allows the use of high-performance digital anti-alias filters in place of the relatively poor performing analog anti-alias filters. In theory, digital anti-alias filters can have extremely sharp cutoff characteristics, and very few negative effects on the in-band audio signal. Digital anti-alias filters are usually designed to achieve at least 100 dB of stop-band attenuation. But, digital filters are designed using the mathematical assumption that the time interval between samples is a constant. Unfortunately, sample clock jitter in an A/D or D/A varies the effective time interval between samples. This variation alters the performance of these carefully designed filters. Small amounts of jitter can severely degrade stop-band performance, and can render these filters useless for preventing aliasing.

The obvious function of a digital anti-alias filter is the removal of audio tones that are too high in frequency to be represented at the selected sample rate. The not-so-obvious function is the removal of high-frequency signals that originate inside the converter box, or even originate inside the converter IC. These high-frequency signals are a result of crosstalk between digital and analog signals, and may have high amplitudes in a poorly designed system. Under ideal (low jitter) conditions, a digital anti-alias filter may remove most of this unwanted noise before it can alias down into lower (audio) frequencies. These crosstalk problems may not become obvious until jitter is present.

Stop-band attenuation can be measured very easily by sweeping a test tone between 24 kHz and at least 200 kHz while monitoring the output of the converter.

## Put *UltraLock*™ converters to the test:

We encourage our customers to perform the above tests on ***UltraLock2™*** converters (or let your ears be the judge). There will be absolutely no change in performance as jitter is added to any digital input on an ***UltraLock2™*** converter. Try the same tests on any converter using conventional single or two-stage PLL circuits. Tests should be performed with varying levels of jitter and with varying jitter frequencies. The results will be very enlightening. Jitter related problems have audible (and measurable) effects on A/D and D/A devices. Practitioners of Digital Audio need to understand these effects.

## Is it possible to eliminate all of the effects of jitter in an entire digital audio system?

**Interface jitter** will accumulate throughout even the most carefully designed digital audio system. Fortunately, **interface jitter** can only degrade digital audio if it affects the sampling circuit in an analog-to-digital or digital-to-analog converter. Any attempt to cure jitter outside of an A/D or D/A will prove expensive and, at best, will only partially reduce jitter-induced artifacts. Dedicated clock signals (word clock, and super clock, etc.) are often distributed to A/D converters and D/A converters in an attempt to reduce jitter. Again, these are only partial solutions because jitter even accumulates in these clock distribution systems. Furthermore, a poor quality master clock generator can degrade the performance of the entire system (if converter performance is dependent upon reference clock quality). Jitter free A/D and D/A converters are the only true insurance against the ill effects of jitter. ***UltraLock2™*** converters are jitter-immune under all operating conditions (they will never add audible jitter induced artifacts to an audio signal).

## What *UltraLock*™ converters cannot do:

***UltraLock2™*** converters cannot undo damage that has already been done. If an A/D with a jitter problem was used to create a digital audio signal, then there is nothing that can be done to remove the damage. Jitter-induced sidebands are extremely complex and cannot be removed with any existing audio device. Therefore, it is very important to attack jitter at both ends of the audio chain. The ***DAC2 HGC*** is a great start, as it will allow accurate assessment of various A/D converters. It is impossible to audibly evaluate A/D performance without a good D/A. The consistent performance delivered by the ***DAC2 HGC*** eliminates one major variable: jitter.

# Multi-Mode Asynchronous USB Audio System

## Plug it in and Start Listening… Immediately

Benchmark's ***Advanced USB Audio*** technology is truly 'Plug and Play'. When connecting to a USB port on a computer running Windows or Mac OSX, the computer will automatically and instantaneously recognize the presence of the Benchmark USB device in USB 1.0, playing tracks up to 96 kHz 24-bit. Any audio played from the computer will then be routed to the Benchmark USB device immediately. There is no software to install or configure.

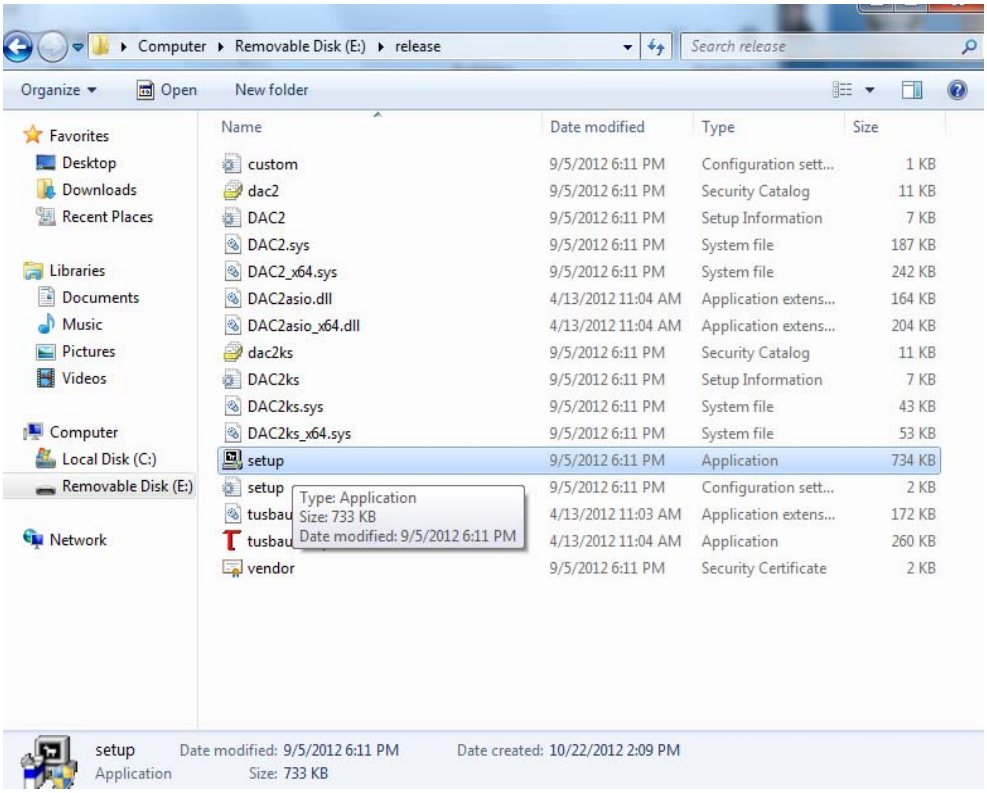
To play tracks up to 192 kHz or DSD on Mac OS X, no driver is required. On Windows XP, Vista, or 7, a driver is required for 192 kHz or DSD playback.

## USB Driver Installation - Windows XP, Vista, 7

**Note:** The ***DAC2 HGC*** driver is available for download at:
*http://www.benchmarkmedia.com/dac/dac2-hgc/driver*

Before you install the driver, make sure the USB is unplugged before installation of the driver.

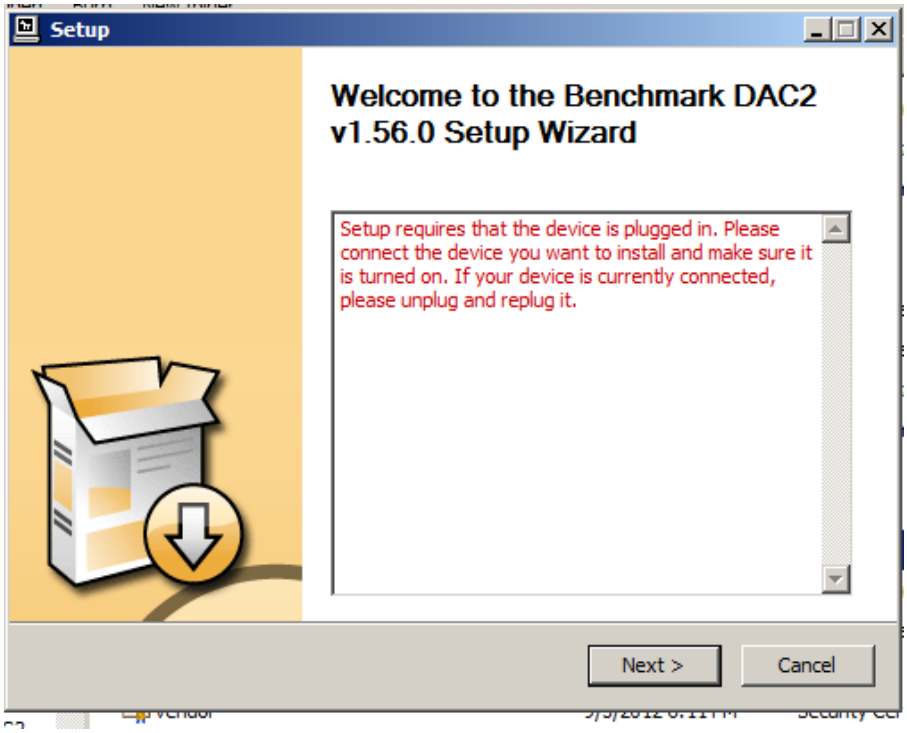
1. **In the DAC2 HGC Driver folder, double click *"setup.exe."***


Computer ▸ Removable Disk (E:) ▸ release
Search release
Organize
Open
New folder
Favorites
Desktop
Downloads
Recent Places
Libraries
Documents
Music
Pictures
Videos
Computer
Local Disk (C:)
Removable Disk (E:)
Network
Name
Date modified
Type
Size
custom 9/5/2012 6:11 PM Configuration sett... 1 KB
dac2 9/5/2012 6:11 PM Security Catalog 11 KB
DAC2 9/5/2012 6:11 PM Setup Information 7 KB
DAC2.sys 9/5/2012 6:11 PM System file 187 KB
DAC2_x64.sys 9/5/2012 6:11 PM System file 242 KB
DAC2asio.dll 4/13/2012 11:04 AM Application extens... 164 KB
DAC2asio_x64.dll 4/13/2012 11:04 AM Application extens... 204 KB
dac2ks 9/5/2012 6:11 PM Security Catalog 11 KB
DAC2ks 9/5/2012 6:11 PM Setup Information 7 KB
DAC2ks.sys 9/5/2012 6:11 PM System file 43 KB
DAC2ks_x64.sys 9/5/2012 6:11 PM System file 53 KB
setup 9/5/2012 6:11 PM Application 734 KB
setup 9/5/2012 6:11 PM Configuration sett... 2 KB
tusbau 4/13/2012 11:03 AM Application extens... 172 KB
tusbau 4/13/2012 11:04 AM Application 260 KB
vendor 9/5/2012 6:11 PM Security Certificate 2 KB
Type: Application
Size: 733 KB
Date modified: 9/5/2012 6:11 PM
setup Date modified: 9/5/2012 6:11 PM Date created: 10/22/2012 2:09 PM
Application Size: 733 KB

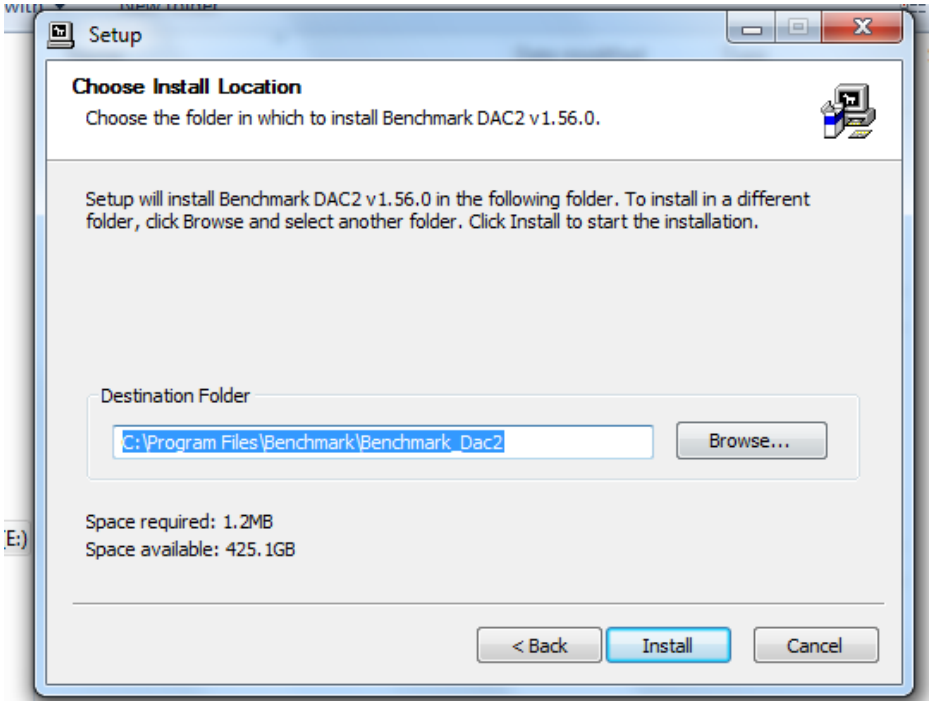
2. **A welcome screen will pop-up. Click "*Next.*"**

Setup
Welcome to the Benchmark DAC2 v1.56.0 Setup Wizard
This wizard will guide you through the installation of Benchmark DAC2 v1.56.0.
It is recommended that you close all other applications before starting Setup. This will make it possible to update relevant system files without having to reboot your computer.
Click Next to continue.
Next >
Cancel

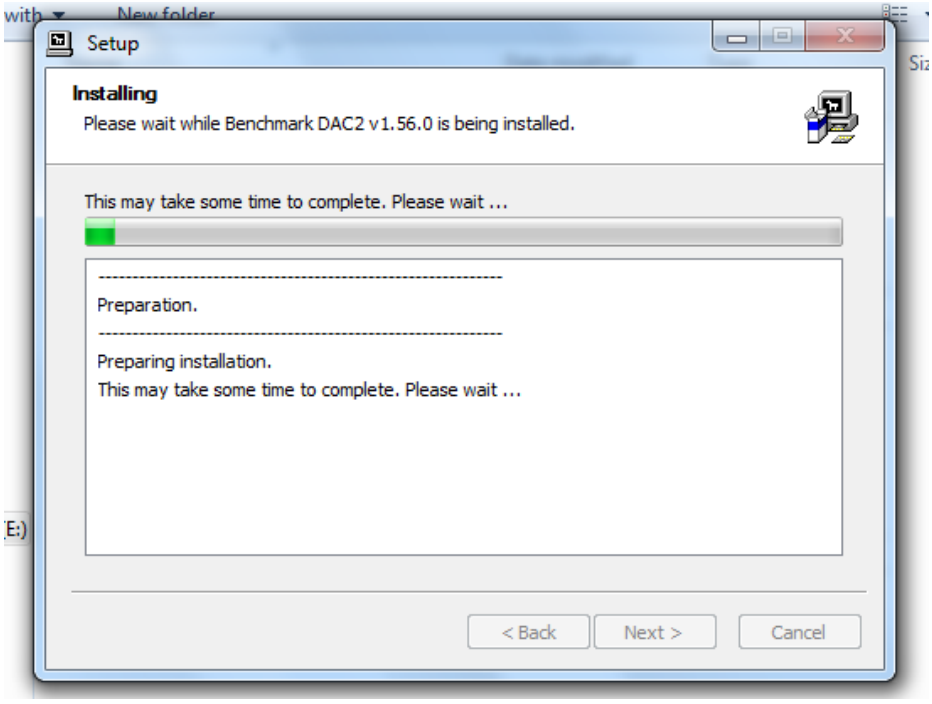
3. **When you see the following screen, plug in the in one of the USB ports and hit *"Next"***


Setup
Welcome to the Benchmark DAC2 v1.56.0 Setup Wizard
Setup requires that the device is plugged in. Please connect the device you want to install and make sure it is turned on. If your device is currently connected, please unplug and replug it.
Next >
Cancel

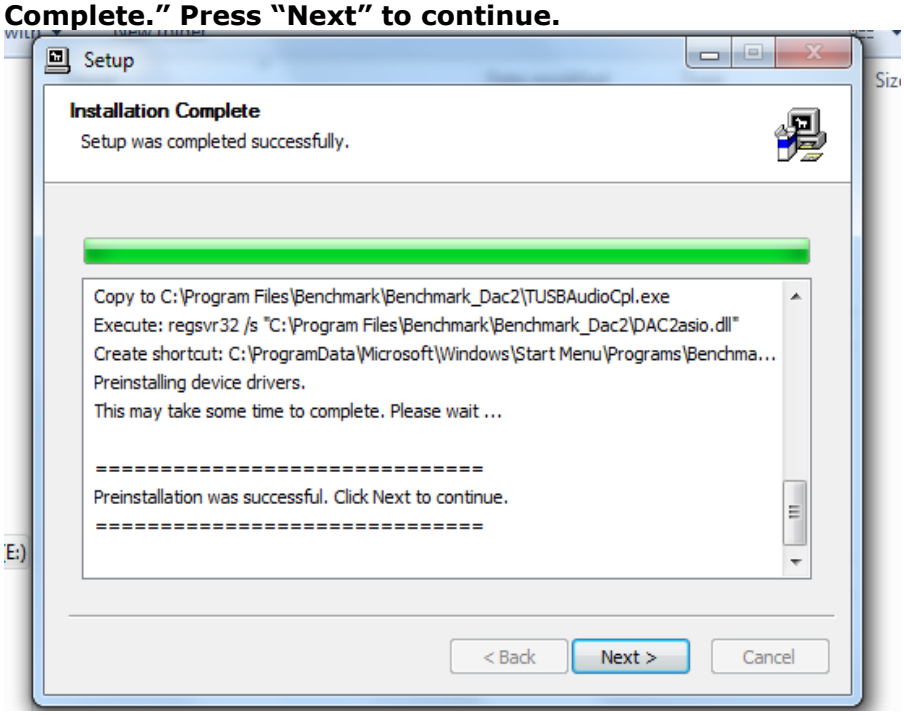
4. **You will be prompted to select a location to install the driver. It will default to your Program Files folder. If you wish to install it another location, you can change the location. We suggest keeping it to the default destination folder.**
**Press "Install"**


Setup
Choose Install Location
Choose the folder in which to install Benchmark DAC2 v1.56.0.
Setup will install Benchmark DAC2 v1.56.0 in the following folder. To install in a different folder, click Browse and select another folder. Click Install to start the installation.
Destination Folder
C:\Program Files\Benchmark\Benchmark_Dac2
Browse...
Space required: 1.2MB
Space available: 425.1GB
< Back
Install
Cancel

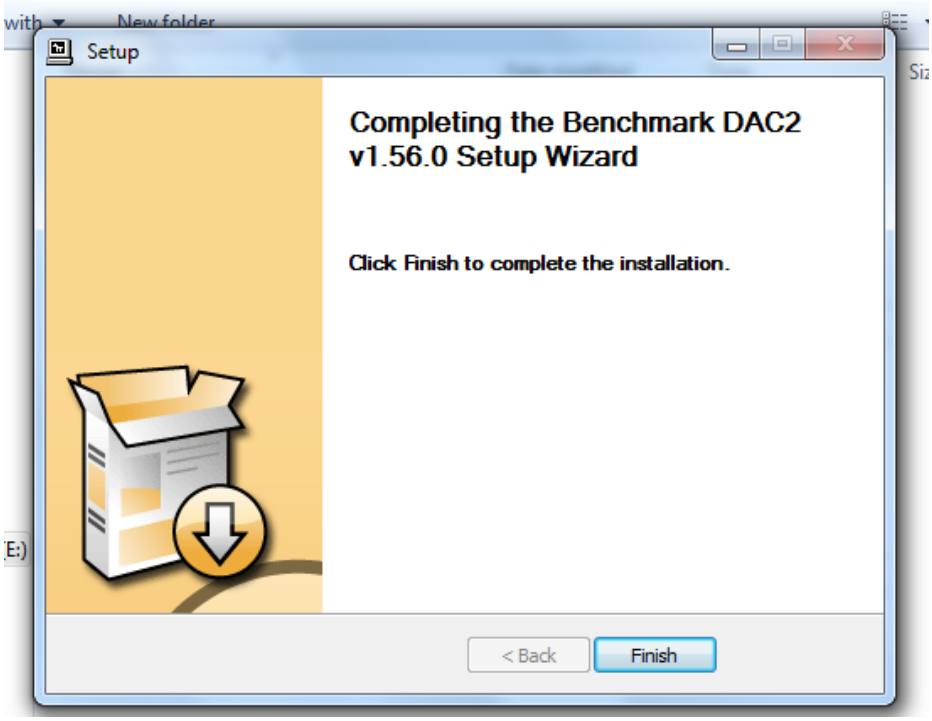
5. **When the installation begins you will see the following screen. Please be patient while the driver installs. Installation time is between 1-5 minutes.**


Setup
Installing
Please wait while Benchmark DAC2 v1.56.0 is being installed.
This may take some time to complete. Please wait ...
Preparation.
Preparing installation.
This may take some time to complete. Please wait ...
< Back
Next >
Cancel

6. **Once the installation finishes a message at the top will say "Installation Complete." Press "Next" to continue.**



7. **Click "Finish." The Setup will close automatically and this completes the installation process. You can now enjoy music up to 192 kHz and DSD.**



# Specifications

## Audio Performance

| *Fs = 44.1 to 96 kHz, 20 to 20 kHz BW, 1 kHz test tone, 0 dBFS = +24 dBu (unless noted)* | |
|---|---|
| SNR – A-Weighted, 0 dBFS = +20 to +29 dBu | 126 dB |
| SNR – Unweighted, 0 dBFS = +20 to +29 dBu | 123 dB |
| THD+N, 1 kHz at 0 dBFS | -109 dBFS, -109 dB, 0.00035% |
| THD+N, 1 kHz at -1 dBFS | -110 dBFS, -109 dB, 0.00035% |
| THD+N, 1 kHz at –3 dBFS | -113 dBFS, -109 dB, 0.00035% |
| THD+N, 20 to 20 kHz test tone at –3 dBFS | -112 dBFS, -108 dB, 0.00040% |
| Frequency Response at Fs=96 kHz | +0 dB, -0.04 dB (20 to 20 kHz)<br><br>-0.04 dB at 10 Hz<br><br>-0.04 dB at 20 kHz<br><br>-0.04 dB at 40 kHz<br><br>-0.7 dB at 45 kHz |
| Frequency Response at Fs=48 kHz | +0 dB, -0.04 dB (20 to 20 kHz)<br><br>-0.04 dB at 10 Hz<br><br>-0.04 dB at 20 kHz |
| Crosstalk | -116 dB at 20 kHz<br><br>-130 dB at 1 kHz<br><br>-137 dB at 20 Hz |
| Maximum Amplitude of Jitter Induced Sidebands (10 kHz 0 dBFS test tone, 12.75 UI sinusoidal jitter at 1 kHz) | < -144 dB |
| Maximum Amplitude of Spurious Tones with 0 dBFS test signal | < -138 dB |
| Maximum Amplitude of Idle Tones | < -147 dB |
| Maximum Amplitude of AC line related Hum & Noise | < -140 dB |
| Inter-channel Differential Phase (Stereo Pair – any sample rate) | +/- 0.25 degrees at 20 kHz |
| Inter-channel Differential Phase (Between ***DAC2 HGC*** Units Fs<110 kHz) Any sample rate. | +/- 0.25 degrees at 20 kHz |
| | |

## Audio Performance (continued)

| | |
|---|---|
| Maximum Lock Time after Fs change | 400 ms |
| Soft Mute Ramp Up/Down Time | 50 ms |
| Mute on Receive Error | Yes |
| Mute on Lock Error | Yes |
| Mute on Idle Channel | No |
| 50/15 us De-Emphasis Enable | Automatic in Consumer Mode |
| De-Emphasis Method | Digital IIR |
| De-Emphasis Supported at | Fs = 32, 44.1, 48 kHz |

## Group Delay (Latency)

| | |
|---|---|
| Delay – Digital Input to Analog Output (function of sample rate) | 1.36 ms at 44.1 kHz<br><br>1.27 ms at 48 kHz<br><br>0.90 ms at 88.2 kHz<br><br>0.82 ms at 96 kHz<br><br>0.51 ms at 176.4 kHz<br><br>0.47 ms at 192 kHz |

## Analog Audio Inputs

| | |
|---|---|
| Number of Analog Inputs (switch selected) | 2 (RCA stereo pair - unbalanced) |
| Number of Channels | 2 |
| Input Impedance | 20 k Ohms |
| Maximum Input Level | +19 dBu |
| Maximum Input @ Factory-set Calibration Levels | +14 dBu |
| DC Blocking Capacitors on Analog Inputs | Yes |
| Transient and Over-Voltage Protection on Analog Inputs | Series R and diode protection |
| Input Capacitance | 10 pF |
| Analog-Input Gain Range | Off to +0.5 dB (RCA in to RCA out)<br><br>Off to +16.5 dB (RCA in to XLR out)<br><br>Off to +10.5 dB (RCA in to Headphone) |
| Factory-Set Analog-Input Gain In Home Theater Bypass Mode | +0 dB (RCA in to RCA out)<br><br>6 dB (RCA in to XLR out) (w/10dB Pad) |

| Digital Audio Inputs | |
|---|---|
| Number of Digital Inputs (switch selected) | 5 (1 USB, 2 Optical, 2 Coaxial) |
| Number of Channels | 2 |
| Input Sample Frequency Range | 28 to 210 kHz (Coaxial)<br><br>28 to 96 kHz (Optical)<br><br>44.1, 48, 88.2, 96, 176.4, 192 kHz (USB) |
| Maximum Input Word Length | 24 bits |
| Digital Input Impedance on Coaxial input (jumper selected) | 75 Ohms |
| DC Blocking Capacitors on Digital Inputs | Yes (Coaxial) |
| Transient and Over-Voltage Protection on Digital Inputs | Yes |
| Minimum Digital Input Level | 250 mVpp on Coaxial |
| Jitter Tolerance (With no Measurable Change in Performance): | >12.75 UI sine, 100 Hz to 3 kHz<br><br>>1.5 UI sine at 20 kHz<br><br>>1.5 UI sine at 40 kHz<br><br>>1.5 UI sine at 80 kHz<br><br>>1.5 UI sine at 90 kHz<br><br>>0.25 UI sine above 160 kHz |
| Jitter Attenuation Method | Benchmark ***UltraLock2***™ - all inputs |

## Balanced Analog Outputs

| | |
|---|---|
| Number of Balanced Analog Outputs | 2 |
| Output Connector | Gold-Pin Neutrik™ male XLR |
| Output Impedance | 60 Ohms (Attenuator off)<br><br>425 Ohms (Attenuator = 10 dB)<br><br>135 Ohms (Attenuator = 20 dB)<br><br>43 Ohms (Attenuator = 30 dB) |
| Analog Output Clip Point | +30 dBu |
| Factory Set Home Theater Bypass Level (at 0 dBFS) | +13 dBu (Attenuator = 10 dB) |
| Output Level Range (at 0 dBFS) In 'Variable' Mode | Off to +23 dBu (Attenuator off)<br><br>Off to +13 dBu (Attenuator = 10 dB)<br><br>Off to +3 dBu (Attenuator = 20 dB) |
| Output Level Variation with Sample Rate (44.1 kHz vs. 96 kHz) | < +/- 0.006 dB |
| | |
| | |
| | |

## Unbalanced Analog Outputs

| | |
|---|---|
| Number of Unbalanced Analog Outputs | 4 |
| Output Connector | RCA |
| Output Impedance | 30 Ohms |
| Analog Output Clip Point | +13.5 dBu |
| Factory Set Home Theater Bypass Output Level (at 0 dBFS) | +7.5 dBu (1.77 Vrms) |
| Output Level Range (at 0 dBFS) | Off to +7.5 dBu |
| Output Level Variation with Sample Rate (44.1 kHz vs. 96 kHz) | < +/- 0.006 dB |
| | |

| *HPA2*™ Headphone Outputs | |
|---|---|
| Number of Headphone Outputs | 2 |
| Output Connectors | ¼" TRS with switch on left-hand jack |
| Output Impedance | < 0.11 Ohms |
| Output Level Control | Stereo Control on Front Panel |
| Output Level Range (at 0 dBFS) into 60-Ohm Load | Off to +17 dBu |
| Maximum Output Current | 250 mA |
| Overload Protection (independent per channel) | Current limited at 300 mA, Thermal |
| Bandwidth | > 500 kHz |
| THD+N | -106 dB, 0.0005% into 30 Ohms at +18 dBu (1.26W) |

| Status Display | |
|---|---|
| Indicators - Type and Location | 16 LED's on Front Panel |
| Selection/Status Indication | 1 – Dim/Mute<br>7 – Input<br>1 – Home Theater Bypass<br>1 – Polarity<br>2 – Word length<br>4 – Sample Rate |

## AC Power Requirements

| | |
|---|---|
| Nominal Input Operating Voltage Range (VAC RMS) | 100 – 240V |
| Frequency | 50-60 Hz |
| Power | < 0.5 Watts Idle<br>12 Watts Typical Program<br>15 Watts Maximum |
| Fuses | 5 x 20 mm (2 required)<br>0.5 A 250 V Slo-Blo® Type |
| Min/Max Operating range (VAC RMS) | 90 – 260<br>47 – 63Hz |

## Dimensions

| | |
|---|---|
| Form Factor | ½ Rack Wide, 1 RU High |
| Depth behind front panel | 8.5” (216 mm) |
| Overall depth including connectors but without power cord | 9.33” (237 mm) |
| Width | 9.5” (249 mm) |
| Height | 1.725” (44.5 mm) |

## Weight

| | |
|---|---|
| ***DAC2 HGC*** only | 3 lb. |
| ***DAC2 HGC*** with remote control, power cord, extra fuses, and manual | 4 lb. |
| Shipping weight | 7 lb. |

# Regulatory Compliance

## FCC and RoHS Compliance Statements

### FCC Notice (U.S. Only)

NOTICE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received including interference that may cause undesired operation.

Instructions to Users: This equipment complies with the requirements of FCC (Federal Communication Commission) equipment provided that following conditions are met:

- RCA Digital Connections: Shielded 75-Ohm coaxial cable must be used.

NOTICE: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

### RoHS Compliant Information

This statement clarifies Benchmark Media Systems, Inc. product compliance with the *EU*'s (European Union) directive 2002/95/EC, or, *RoHS* (Restrictions of Hazardous Substances).

As of July 01, 2006, All Benchmark Media Systems, Inc. products placed on the European Union market are *compliant* (containing quantity limit weight less than or equal to 0.1% (1000 ppm) of any homogeneous Lead (Pb), Mercury (Hg), Hexavalent Chromium (Cr VI), and flame retardant Polybrominated Biphenyls (PBB) or Polybrominated Diphenyl Ethers (PBDE)).

## CE Certificates of Conformity

# Certificate of Conformity

Diversified T.E.S.T. Technologies, Inc. has tested the product to the current appropriate standards and finds that the product is in compliance with those requirements.

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| | | |
|---|---|---|
| **EMC Directive:** | **2004/108/EC** | |
| Generic Emissions Standard: | EN 61000-6-3: 2007/A1:2011 | |
| Product Specific Emissions: | EN 55011 Class A | |
| Generic Immunity Standard: | EN 61000-6-1: 2007 | |
| Immunity: | EN 61000-4-2 | Electrostatic Discharge |
| | EN 61000-4-3 | Radiated Susceptibility |
| | EN 61000-4-6 | Conducted Susceptibility |

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| | |
|---|---|
| Manufacturer's Name: | **Benchmark Media Systems** |
| Manufacturer's Address: | 203 East Hampton Suite 2<br>Syracuse, NY 13206 |
| Product: | DAC2HGC |
| Model Number: | 500-14800-XXX * |

* Where XXX indicates a color code.

---

This Certificate of Compliance issued September 21, 2012 is valid for the test sample of the product specified above and that it conforms to the Directive(s) and Standard(s).

Signature: _____

Annelle Frierson
Vice President
Diversified T.E.S.T. Technologies, Inc.
4675 Burr Drive
Liverpool, NY 13088
Phone: 315-457-0245
Fax: 315-457-0428

DIVERSIFIED T.E.S.T. TECHNOLOGIES, INC. CORPORATE SEAL 1991 NEW YORK

# Warranty Information

## Benchmark 1 Year Warranty

### The Benchmark 1 Year Warranty

Benchmark Media Systems, Inc. warrants its products to be free from defects in material and workmanship under normal use and service for a period **of one (1) year from the date of delivery.**

This warranty extends only to the original purchaser. This warranty does not apply to fuses, lamps, batteries, or any products or parts that have been subjected to misuse, neglect, accident, modification, or abnormal operating conditions.

In the event of failure of a product under this warranty, Benchmark Media Systems, Inc. will repair, at no charge, the product returned to its factory. Benchmark Media Systems, Inc. may, at its option, replace the product in lieu of repair. If the failure has been caused by misuse, neglect, accident, or, abnormal operating conditions, repairs will be billed at the normal shop rate. In such cases, an estimate will be submitting before work is started, if requested by the customer.

Attempts to deliberately deface, mutilate, or remove the product's label will render this warranty void. Any DAC2 HGC returned from the European Union for warranty repair must have the required RoHS logo on the product label; otherwise, repairs will be billed at the normal shop rate. Benchmark will not honor warranties for any products disingenuously purchased on the US or Canadian markets for sale outside the US or Canada.

The foregoing warranty is in lieu of all other warranties, expressed or implied, including but not limited to any implied warranty of merchantability, fitness or adequacy for any particular purpose or use. Benchmark Media Systems, Inc. shall not be liable for any special, incidental, or consequential damages, and reserves the right to charge this information without notice. This limited warranty gives the consumer-owner specific legal rights, and there may also be other rights that vary form state to state.

# Benchmark Extended Warranty

## The Benchmark Extended 5* Year Warranty

Benchmark Media Systems, Inc. optionally extends the standard one (1) year warranty to a period of **five (5)* years from the date of delivery.**

*For the extended warranty to become effective, the original purchaser must register the product at the time of purchase either by way of the enclosed registration card or through the product registration section of the Benchmark Media Systems, Inc. website. This optional warranty applies only to products purchased within the US and Canada and is extended only to the original purchaser.

Attempts to deliberately deface, mutilate, or remove the product's label will render this warranty void. Benchmark will not honor warranties for any products disingenuously purchased on the US or Canadian markets for export. The terms of the extended warranty are subject to change without notice. For products purchased outside the US and Canada, please refer to the Extended Two (2)** Year International Warranty.

## The Benchmark's Extended 2** Year International Warranty

Benchmark Media Systems, Inc. optionally extends the standard one (1) year warranty to a period of **two (2)** years from the date of delivery.**

**For the extended warranty to become effective, the original purchaser must register the product at the time of purchase either by way of the enclosed registration card or through the product registration section of the Benchmark Media Systems, Inc. website. This optional warranty applies only to products purchased outside the US and Canada and is extended only to the original purchaser.

Attempts to deliberately deface, mutilate, or remove the product's label will render this warranty void. Benchmark will not honor warranties for any products disingenuously purchased on the US or Canadian markets for export. The terms of the extended warranty are subject to change without notice. For products purchased in within the US and Canada, please refer to the Extended Five (5)* Year Warranty.

## Notes on Warranty Repairs

An RMA (return merchandise authorization) number, issued by our Customer Service Department, is required when sending products for repair.

They must be shipped to Benchmark Media Systems prepaid and preferably in their original shipping carton with the RMA number clearly visible on the exterior of the packaging. A letter should be included giving full details of the difficulty.

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